

APPLICATION FOR  
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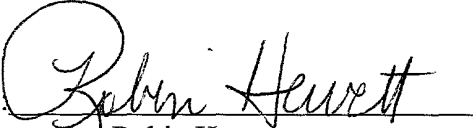
FOR  
**REGULATORY GATE SYSTEM FOR PRODUCT  
DROP OFF OF VIBRATORY CONVEYORS**

By:

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I hereby certify that the enclosed Application is being deposited with the United States Postal Service via Express Mail service, as Express Mail No. **EL#750740542US** in an envelope addressed to: BOX – NEW Patent Application, Assistant Commissioner for Patents, Washington, D.C. 20231, on January 31, 2001.

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## **BACKGROUND OF THE INVENTION**

### 1. Technical Field

The present invention relates to an improved product conveyor apparatus and, in particular, to a product conveyor apparatus which provides for a laminar flow of product to downstream gates thereby increasing the efficiency of downstream bagmakers for a given conveyor line.

### 2. Description of Related Art

A vibratory conveyor is a commonly used device in the food industry for transporting products such as potato chips to weighers. In most packaging lines, a product is moved along vibratory distribution conveyors having multiple sets of product weighers placed beneath the length of the conveyor. When a set of weighers requires product, a slide gate opens in the bottom of the distribution conveyor to drop product onto a cross-feeder conveyor which serves that set of weighers. It is possible that the product might pass over all of the slide gates without being dropped because the slide gates are closed when the product passes over. Rather than simply discarding the product that was not dispensed from the distribution conveyor, a recirculation conveyor is typically used to re-route the undispensed product back to the beginning of the distribution conveyor.

An example of a prior art design in this regard is illustrated by **Figure 1A**. Throughout the specification, the same numerals are used to denote like parts unless otherwise indicated.

**Figure 1A** shows a top view of a distribution conveyor **100** with a plurality of slide gates **105** and a recirculation conveyor **115**. The distribution conveyor **100** consists of multiple sections of distribution conveyor pans (not shown), each having a plurality of slide gates **105** mounted in the

bottom of the conveyor pan. The conveyor pans vibrate in the direction of product flow **125**. In operation, the pan drops downward and in the opposite direction of product flow, and then lifts upward and forward in the direction of product flow **125** at a high frequency. In this manner, the product is moved to a higher elevation at the end of each distribution conveyor pan before it is  
5 dumped onto the next distribution conveyor pan at a lower elevation.

The slide gates **105** are each controlled by a pneumatic controller connected to product level sensors on a cross-feeder conveyor serving a set of weighers located to one side and beneath the slide gate **105**. The controller opens the slide gate **105** when more product is needed on the cross-feeder conveyor serving the set of weighers. An ultrasonic level sensor may be used on this cross-feeder conveyor to determine when more product should be dispensed from the distribution conveyor. Thus, each slide gate **105** operates independently of the other slide gates. The recirculation conveyor pans (if used) are similar in operation to the distribution conveyor pans except that they may not have slide gates, operating simply to move the product back to the initial stage **120** of the distribution pan **100**.

**Figure 1B** shows the distribution conveyor **100** in operation. The product **140**, such as potato chips, comes out of the kitchen and is deposited onto the initial stage **120** of the distribution conveyor **100**. It passes over multiple slide gates until it is dropped into an open slide gate **105**. If the product passes over all of the slide gates without being dropped, then it is either dumped as waste or deposited onto the upstream end **130** of the recirculation conveyor **115**  
20 and re-routed back to the initial stage **120** of the distribution conveyor **100**. In a typical prior art system, approximately 20% of the product is re-routed down the recirculation conveyor back to the distribution conveyor. One of the reasons for this is that the slide gates only open

periodically. When a gate opens, most, if not all, of the product upstream of the gate is deposited as it reaches the gate with very little product allowed to bypass the gate until it is completely shut. Some gates extend across the entire width of the conveyor pan while other gates extend over a substantial portion of the width of the conveyor. The prior art slide gates operate such that they are either fully opened or fully closed. Because the slide gate **105** extends across the entire width or at least a substantial portion of the width of the distribution conveyor, this on/off system results in gaps **110** in the product forming on the conveyor downstream of the slide gate **105**. Thus, when a slide gate further downstream opens, there is a good chance that there will be no product immediately available and the set of weighers fed through that slide gate will be starved of product. This means that the weighers/bagmakers are operating inefficiently because they do not always have product available when needed. Using the systems of the prior art, additional weighers/bagmakers must be attached to the conveyors to obtain a higher throughput even though the weighers are not being operated at 100% of their capacity. This increases the overall cost of the product line. A smaller number of weighers/bagmakers would be required for a given throughput if a laminar flow of product were available to the weighers. For example, if the desired throughput is 4000 bags per hour on a product line and each bagmaker has a capacity of 1000 bags per hour, a non-laminar flow of product may decrease the efficiency of each bagmaker to 80% or 800 bags per hour. Thus, in order to get the desired throughput of 4000 bags per hour, at least five bagmakers must be used. However, if a laminar flow of product is provided such that the bagmakers operate at 100% efficiency, then only four bagmakers would be required for the desired throughput.

A non-laminar product flow also causes more of the product to be re-circulated on the

recirculation conveyor **115**. The longer the product remains on the conveyor, the more it cools and, consequently, the more moisture that is absorbed by the product. As the product is circulated from the distribution conveyor **100** to the recirculation conveyor **115** and back to the distribution conveyor **100**, it will decrease in temperature to the point that the vapor pressure of the product is exceeded by the surrounding atmosphere. When this happens, the product absorbs moisture from the atmosphere, increasing its moisture content. Excess moisture in a packaged product can lead to premature staling. The shelf life of the packaged product is therefore reduced when the product makes a subsequent pass on the distribution conveyor **100**. Furthermore, even if only a portion of the product packaged in a bag had been recirculated, the absorbed moisture of the recirculated product would also affect the product that had not absorbed any moisture, causing it to go stale faster as well.

Environmental conditions of the room can be controlled by increasing the temperature and decreasing the humidity. This is not a feasible solution because the equipment needed to control the environment in the room is extremely expensive to purchase, operate, and maintain. Another alternative is to keep the product warmer by using infrared heaters placed above the product. Using this method to keep the product warm, the product could theoretically be circulated for hours at higher than room temperature without absorbing moisture from the ambient air. However, the obvious shortcoming of this solution is that it would require an electrical or gas energy source. This added energy cost decreases the profitability of the operation and makes it a much less attractive solution. Further, maintaining the product at an elevated temperature for an extended period of time could affect the characteristics and quality of the product.

In U.S. Patent Application No. 09/417,962, hereby incorporated by reference as if fully set forth herein, the inventor of the present invention discloses a stopper gate that reduces the amount of product that is recirculated on the recirculation conveyor. However, the stopper gate system disclosed therein does not eliminate all flow fluctuations of product on the distribution conveyor that causes the weighers/bagmakers to operate inefficiently.

Thus, the best solution is to develop a method and apparatus for dispensing the product into the weighing mechanism as soon as possible after it enters the packaging line, preferably on the first pass of the product through the distribution conveyor. The system should provide for a laminar flow of product to be fed into the weighing mechanism to avoid any starvation of the weighers and to reduce the amount of product that is recirculated. With such a system, the weighers may be operated at maximum capacity, thereby requiring fewer weighers for a given throughput on the product line.

## **SUMMARY OF THE INVENTION**

The present invention is an improved method and apparatus for distributing a food product, such as potato chips to a set of weighers. The invention provides a laminar flow of product to the weighers by using a gate which regulates the amount of product dropped through the distribution conveyor to an amount that is equivalent to the flow rate required by the set of weighers/bagmakers associated with that gate. The gate is constructed such that it may be partially open to allow some product to be dropped through the gate while concurrently bypassing the remainder of the product. This results in a steady stream of product continuing downstream for deposit in a subsequent gate. Thus, the downstream weighers/bagmakers are not starved of product because of product voids on the distribution conveyor. Consequently, a higher throughput may be obtained with the same number of weighers while the amount of product recirculated is also reduced. The above as well as additional features and advantages of the present invention will become apparent in the following written detailed description.

## BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself, however, as well as a preferred mode of use, further objectives and advantages thereof, will be best understood by reference to the following detailed description of illustrative embodiments when read in conjunction with the accompanying drawings wherein:

**Figure 1A** is an overhead schematic of a prior art conveyor system.

**Figure 1B** is an overhead schematic of a prior art conveyor system in operation.

**Figure 2** is a perspective view of a portion of a conveyor system in accordance with an embodiment of the present invention.

**Figure 3A** is a top view of a finger gate in accordance with one embodiment of the present invention.

**Figure 3B** is a bottom view of the finger gate of **Figure 3A** in accordance with one embodiment of the present invention.

**Figure 3C** is a cross-sectional view of the finger gate of **Figures 3A** and **3B**.

**Figure 4A** is a bottom view of a V-gate in a partially closed position in accordance with one embodiment of the invention.

**Figure 4B** is a bottom view of a V-gate in an open position in accordance with one embodiment of the invention.

**Figure 5** is a perspective view of a diverter gate in accordance with one embodiment of the present invention.

## DETAILED DESCRIPTION

**Figure 2** is a perspective view of a portion of a conveyor system in accordance with an embodiment of the present invention. Product flows down distribution conveyor **100** and is dropped through an open slide gate **215a** onto a cross-feeder conveyor **205a** for a set of weighers **210a**. The cross-feeder conveyor **205a** may also be a vibratory conveyor similar to the distribution conveyor **100**. The slide gate **215a** is generally only partially open to allow some of the product to bypass the slide gate to be dropped through the remaining slide gates. By regulating the size of the opening of the slide gate **215a**, the volume of product to the cross-feeder conveyor **205a** is regulated to an amount that provides a steady flow of product to the set of weighers **210a** without creating a void in the product on the distribution conveyor **100**. The vibration of the distribution conveyor **100** has a tendency to distribute the remainder of the product across the width of the conveyor after it passes over a partially open slide gate **215a**. Thus, there are no voids in the flow of product once it reaches a subsequent slide gate **215b**.

**Figure 3A** is a top view of a finger gate in accordance with one embodiment of the present invention. Rather than have one solid slide gate that is either open or closed, the embodiment illustrated provides three separate fingers **310a**, **310b**, and **310c** which are independently actuated by pneumatic actuators **315a**, **315b**, and **315c** located underneath the distribution conveyor **100**. When one finger is opened, a slot is created which is aligned with the direction of product flow. This allows all of the product flowing down a path in-line with the slot to be dropped while the product that is not flowing down that path continues flowing downstream to be dropped through a subsequent slide gate. In operation, the fingers may be all closed at one time; one finger may be open and the other two closed; two fingers may be open

and the third finger closed; or all three fingers may be open. In one embodiment, the right finger **310c** opens first, followed by the middle finger **310b** and finally the left finger **310a**. The fingers are closed in the reverse sequence. However, other sequencing combinations can be used in the alternative without departing from the scope and spirit of the invention. In this embodiment, the opening size created by opening the first finger **310c** is set to provide the proper throughput to the cross-feeder conveyor for the set of weighers when a normal level of product is flowing down the distribution conveyor **100** and all of the weighers/bagmakers are operating properly. This is referred to as a normal mode of operation. However, if the product level on the distribution conveyor is lower than normal or if there is a sudden demand for product by the weighers, then it may be necessary to open more than one of the fingers.

The number of fingers open at any given time depends on the level of the product sensed by one or more ultrasonic level sensors in the cross-feeder conveyor **205** associated with the slide gate **215**. Thus, the slide gate provides a regulatory function in that it regulates the size of the opening **315** to control the amount of product that is allowed to flow through the slide gate **215**. By controlling the opening **315** to regulate the product until a steady flow of product is achieved, a laminar flow along the distribution conveyor **100** and the cross-feeder conveyor **205** is provided. When only one or two of the fingers are open, some of the product bypasses the slide gate **215** for deposit through subsequent slide gates. Once product passes the slide gate **215**, the vibration of the conveyor redistributes the product evenly across the width of the conveyor **100** before it reaches a subsequent slide gate. Thus, the flow of product downstream of the finger gate **215** is much more laminar than it is if the single-piece slide gate of the prior art is used. In practice it has been observed that the left finger **310a** usually remains closed. The middle finger

310b opens and closes as the needs of the set of weighers change, and the right gate 310c usually always remains open. Although the number of fingers used in the embodiment illustrated is three, the invention is not limited to three fingers. More fingers may be used to provide for a greater number of sizes for the slide gate opening.

5           **Figure 3B** is a bottom view of the finger gate of **Figure 3A** in accordance with one embodiment of the present invention. Only the right finger 310c is in the open position. The finger gates 310a, 310b, and 310c are each actuated using independently operated pneumatic actuators 315a, 315b, and 315c. The fingers may be constructed of Ultra High Molecular Weight (UHMW) polymer boards with a bracket 320 attached to each of the fingers 310a, 310b, and 310c. The bracket 320 is attached to the ram of a pneumatic actuator for each finger. The actuators 315a, 315b, and 315c are controlled by a controller which has an analog connection to an ultrasonic sensor that is placed on the cross-feeder conveyor 205a located below the distribution conveyor 100, as shown in **Figure 2**. A suitable controller is the Model PAXP single loop controller manufactured by Red Lion. Ultrasonic sensors are used extensively in the food industry to measure product level because of their accuracy. A suitable sensor is the Hyde Park SM956 series. However, the invention is not limited to this particular ultrasonic sensor or loop controller. Any sensor capable of detecting a pre-defined product level at a particular location on the cross-feeder conveyor is sufficient for the purposes of this invention. Likewise, any controller that is capable of operating the three actuators to regulate the size of the opening is sufficient for the purposes of this invention.

The controller is programmed to maintain the product level in the cross-feeder conveyor at a predetermined operating level, such as two inches. When the product line is first started with

no product in the distribution conveyor, the controller opens all three fingers **310a**, **310b**, and **310c**. Once the product builds up on the cross-feeder conveyor to more than the predetermined operating level, the left finger **310a** is first closed. After a predetermined period of time, the controller will close the middle finger **310b** if the product level is still above the predetermined operating level. The controller then waits for the predetermined period of time and if the product is still above the predetermined operating level, the right finger **310c** is closed. The same procedure is followed when the product drops below the predetermined operating level except that the gates are opened one at a time in the reverse order until the product rises back to the predetermined operating level.

The controller uses a debounce timer to desensitize the system so that the fingers on the slide gate are not constantly opening and closing. Naturally, the product level on the cross-feeder conveyor may drop rapidly when the slide gate is closed or rise rapidly when all three fingers are open, but it is not desirable for a finger to open immediately after it is closed, or vice versa. The debounce timer is simply a delay created by the software of the control system that keeps the finger on the slide gate open (closed) for a predetermined time period before allowing it to close (open) again, regardless of the level of product sensed on the cross-feeder conveyor.

**Figure 3C** is a cross-sectional view of the finger gate of **Figures 3A** and **3B** oriented as shown in **Figure 3A**. The view shows the dovetail grooves **320** on the edges of the fingers that allow the fingers to interlock and prevent product from becoming lodged between the fingers.

The fingers interlock laterally while the fingers are allowed to slide freely in a longitudinal direction parallel to the direction of product flow. Stationary mounting strips **325a**, **325b** are attached near the outer edges of the opening of the distribution conveyor **100** to interlock with

and hold the outer fingers **310a**, **310c** in place. Because the outer fingers **310a**, **310c** are interlocked laterally with the middle finger **310b**, the middle finger is also held in position by the stationary mounting strips **325a**, **325b**.

**Figure 4A** is a bottom view of a V-gate in a partially closed position in accordance with an alternative embodiment of the invention. The slide gate **405** illustrated in this embodiment is referred to as a V-gate **405** because of the movement of the gate. Two rectangular pieces of UHMW board **410a**, **410b**, or other suitable material, are attached to a pneumatic actuator **415** which operates parallel to a longitudinal axis of the distribution conveyor **100** to vary the size of the opening in the gate. The end of the actuator ram **435** is rigidly attached to a coupling linkage **430** which is perpendicular to the actuator ram **435**. The ends of the coupling linkage **430** contain holes for mounting the links **440a**, **440b** that connect the UHMW boards **410a**, **410b** to the coupling linkage **430**. Each end of the links **440a**, **440b** houses a bearing surface to allow the links **440a**, **440b** to rotate as the slide gate is opened and closed.

The UHMW boards **410a**, **410b** contain symmetrical grooves (not shown) to accept the guides **420a**, **420b** which are attached rigidly to the bottom of the distribution conveyor **100** such that the guides form a "V." The angle between the guides is twice the acute angle formed between one of the grooves and the longitudinal axis of the distribution conveyor **100**. Thus, the V-gate is symmetrical about the longitudinal axis of the distribution conveyor **100**. The guides may be fabricated from square stock steel and attached to the bottom of the distribution conveyor. Thus, whenever the actuator ram **435** is operated in a rearward direction **425**, the boards **410a**, **410b** are forced apart by the guides **420a**, **420b** and whenever the actuator is operated in a forward direction, the boards **410a**, **410b** are forced together by the guides. **Figure**

4A shows the V-gate 405 in a slightly open position while Figure 4B shows the V-gate in a more fully open position. Whenever the gate is opened, the actuator pulls the UHMW boards 410a, 410b in the rearward direction 425, forcing the boards toward the outside edges of the distribution conveyor 100, thereby providing an opening 445 for the product to fall through. A pneumatic actuator 415 may be used with the V-gate just as it is used in the embodiment shown in Figure 3A and Figure 3B. However, only one actuator is required for the V-gate embodiment. Thus, the existing pneumatic actuator may be used in converting a prior art system to the V-gate embodiment. The actuator may be controlled using a programmable logic controller such as the Position X Remote PLC manufactured by Robohand, Inc.

Figure 5 is a perspective view of a diverter gate in accordance with another embodiment of the present invention. The diverter gate of Figure 5 is different from the finger gate or the V-gate described above in that the opening 505 in the distribution conveyor 100 remains open at all times. The amount of product flow through the opening 505 is controlled by the diverter 510. The diverter 510 is rotably attached to the structure of the distribution conveyor such that it pivots about a bearing surface 515. The diverter 510 is moved from side to side to control the amount of product that is allowed to flow through the opening 505. If no product is needed by the weigher associated with the opening 505, then the diverter 510 is moved to the left side 520 of the distribution conveyor such that all of the product is bypassed around the opening 505. The position of the diverter 510 is varied such that the proper flow rate of product through the opening 505 is obtained. The position of the diverter 510 may be controlled using a magnetically coupled rodless cylinder 530 such as a Festo Type DGO. The cylinder is attached to the diverter 510 using UHMW swivel blocks 535 or other suitable connections. As the actuator 530 moves

from side to side, the diverter **510** swings from side to side. The swivel blocks **535** allow the diverter **510** to move within the swivel blocks. The same programmable logic controller used for the V-gate described above may be used for controlling the diverter gate.

The above conveyor systems present novel and non-obvious features in the product packaging field. Several gates are described which are capable of satisfying the several objects of this invention. However, this invention should not be construed to be limited to the specific constructions described herein, but rather may be embodied in structures which change one or several of the disclosed features of the illustrated gates. It is to be understood that the invention is intended to cover all changes and modifications to the gates as depicted herein, and all other embodiments not specifically illustrated, which do not constitute a departure from the true spirit and scope of this invention.

For example, the dimensions may be changed to increase or decrease the overall size of the gates; the shapes and number of the finger gates, V-gates, or diverter gates may also be changed; the individual materials and devices may be changed to other comparable materials which accomplish the same purpose; and products other than potato chips may be used with the invention. Although not shown in the drawings, the invention may also be used in combination with the stopper gate disclosed in U.S. Patent Application No. 09/417,962 to help reduce the amount of product that is recirculated. The invention could also be used in the industry where conveyors are used to distribute products other than food products.